

CLAIMS

1. A method of processing a mixed-phase stream comprising:
introducing the mixed-phase stream into a heat exchanger; and
5 inducing the mixed-phase stream into spiral flow path.
2. The method as set forth in claim 1, further comprising a step of heating at least a portion of the mixed-phase stream.
- 10 3. The method as set forth in claim 1, wherein the step of inducing the spiral flow path comprises flowing the mixed-phase stream by a spiral-shaped element.
4. The method as set forth in claim 1, further comprising a step of vaporizing any volatile component from the mixed-phase stream to produce a substantially dry solid
15 product.
5. The method as set forth in claim 4, wherein the substantially dry solid product is suitable for animal feed.
- 20 6. The method as set forth in claim 1, wherein the mixed-phase stream comprises stillage.
7. The method as set forth in claim 1, further comprising a step of hydroblasting a tube of the heat exchanger with a lance.
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8. The method as set forth in claim 1, wherein the step of inducing the mixed-phase stream into a spiral flow path comprises introducing the mixed-phase stream into a tube of a heater having disposed therein a unitary spiral-shaped element.
- 30 9. A method of increasing solids concentration in a biomaterial stream having solid and liquid fractions comprising:
inducing non-turbulent spiral flow within a heat exchanger tube;

heating the biomaterial stream; and
vaporizing at least a portion of the liquid fraction from the biomaterial stream.

10. The method as set forth in claim 9, further comprising a step of drying the
5 biomaterial stream to produce substantially dry solid product.

11. A system for processing a biomaterial stream comprising a biomaterial source in
communication with a heater comprising a spiral-shaped element disposed in at least one
heater tube.
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12. The system as set forth in claim 11, wherein the spiral-shaped element has a width
spanning less than about 50% of an inside diameter of the heater tube.

13. The system as set forth in claim 11, wherein the biomaterial source comprises a
15 grain processing facility.

14. The system as set forth in claim 13, wherein the grain processing facility
comprises at least one of grain handling, fermentation, distillation and dehydration unit
operations.
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15. A system for processing biomaterial comprising:
a grain handling unit operation;
a grain fermentation unit operation in communication with the grain handling unit
operation;
25 a distillation unit operation in communication with the fermentation unit
operation;
an evaporation unit operation in communication with the distillation unit
operation; and
and a concentrator in communication with the evaporation unit operation, the
30 concentrator comprising a heat exchanger comprising a spiral-shaped element disposed
within a tube of the heat exchanger.

16. The system as set forth in claim 15, wherein the spiral-shaped element has width spanning less than an inside diameter of the tube.
17. The system as set forth in claim 15, wherein the biomaterial comprises corn.
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18. A system for processing grain comprising:
a grain steeping unit operation;
a grinding unit operation downstream of the grain steeping unit operation;
a germ separation unit operation downstream of the grinding unit operation;
10 filtration and washing unit operations receiving material from the germ separation unit operation; and
a concentrator receiving heavy steep stream from the grain steeping unit operation, the concentrator comprising a heat exchanger comprising a spiral-shaped element disposed within a tube of the heat exchanger.
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19. The system as set forth in claim 18, wherein the spiral-shaped element has width spanning less than an inside diameter of the tube.
20. The system as set forth in claim 19, wherein the spiral-shaped element is sized to permit internal cleaning of the heat exchanger tube with a hydroblasting lance.
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21. A method of improving the heat transfer properties of a heat exchanger comprising installing an element into at least one heat exchanger tube that can induce a mixed-phase stream flowing therein into a spiral flow path.
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22. The method as set forth in claim 21, wherein the element comprises a spiral-shaped element spanning at least a portion of the tube.
23. The method as set forth in claim 22, wherein the spiral-shaped element has an aspect ratio that is about 5.
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24. The method as set forth in claim 21, wherein the step of installing the element comprises inserting a ribbon into the heat exchanger tube and winding the ribbon to twist the ribbon by at least one rotation into a spiral-shaped element.